Supplemental Information for

Photovoltaic performance of ultra-small PbSe quantum dots

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Synthesis of Ultra-Small PbSe Nanocrystals:

We used eight different batches of PbSe nanocrystals in this study, with sizes varying from 1.1nm to 2.8nm. For each batch, the synthesis follows in the recipe given, with the growth conditions found in Table S1.

Growth Temperature (degrees C)	Growth Time	Nanocrystal Diameter (nm)
30	30 min	1.1
60	15 min	1.5
80	10 min	1.88
100	5 min	1.93
120	2 min	2.2
140	90 sec	2.3
160	60 sec	2.6
180	30 sec	2.9

Table S1: Growth temperature and growth time to achieve the PbSe nanocrystal sizes presented in this work.

Effect of thiol treatment on Photoluminescence:

We found that the PL intensity increased by a factor of 10 when 0.1% octadecanethiol was added to the quantum dot solution, as shown in Figure S1. Adding more thiol, however, resulted in a reduction of the PL and a red shift of the peak. Barkhouse *et al.*[1] have attributed this effect to destabilization of the colloid with excess thiol due to displacement of the native oleic acid ligands, causing the nanoparticles to aggregate.

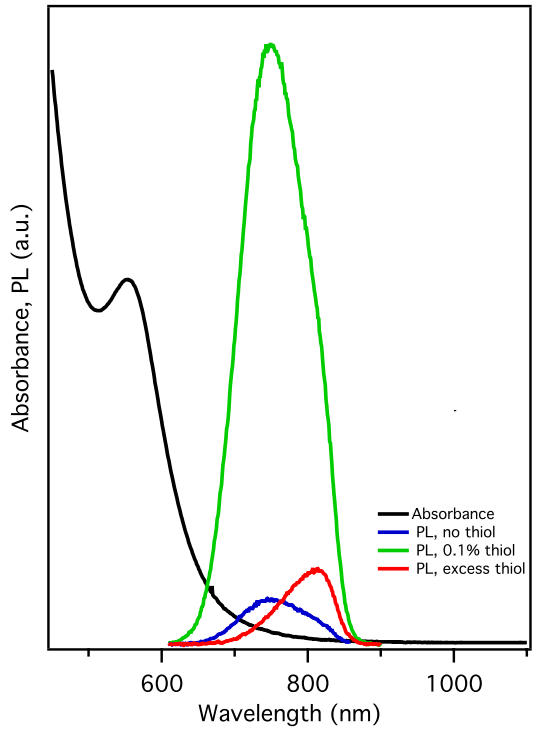

Figure S1: The PL is initially increased by a factor of 10 with the addition of octadecanethiol to the nanoparticle solution. Excess thiol causes a decrease in the intensity and a red shift of the PL peak.

External Quantum Efficiency (EQE):

EQE curves for all eight nanocrystal sizes are shown in Figure S2.

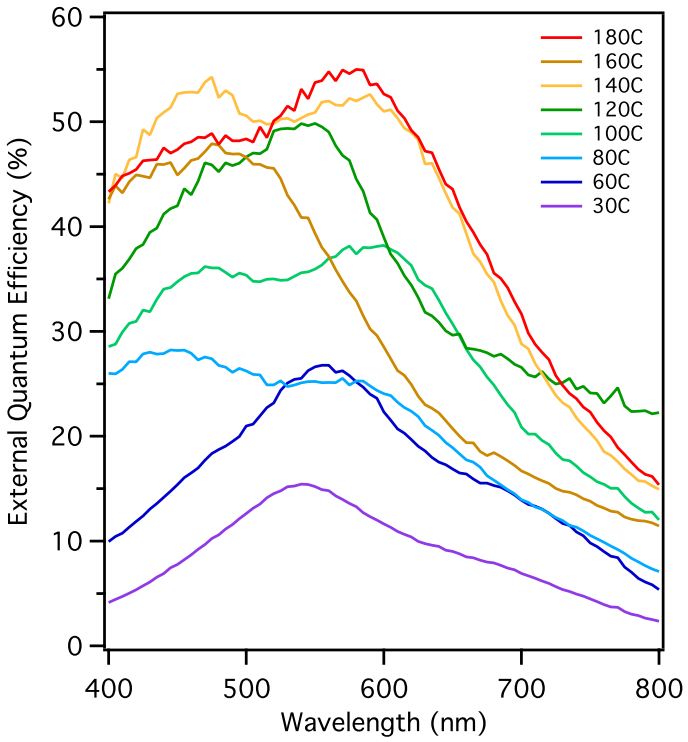

Figure S2: EQE curves for devices made with each of the eight nanocrystal samples presented in this work.

References

1. Barkhouse, D. A. R.; Pattantyus-Abraham, A. G.; Levina, L.; Sargent, E. H., Thiols passivate recombination centers in colloidal quantum dots leading to enhanced photovoltaic device efficiency. *ACS nano* **2008,** *2* (11), 2356-2362.